Senior High School

DepED
DEPARTMENT OF EDUCATION

Earth Science

Quarter 2 - Module 9
Earth's Interior and its Mechanisms

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Earth Science- Grade 12
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Quarter 2 - Module 9: Earth's Interior and Its Mechanisms
First Edition, 2020

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Published by the Department of Education – Division of Cagayan de Oro
Schools Division Superintendent: Dr. Cherry Mae L. Limbaco, CESO V

Development Team of the Module

Author: Princess Khraye Arianne Marie P. Sundo and Kim S. Casiño
Reviewers: Jean S. Macasero,Ph.D EPS, Evelyn Q. Sumanda, Cely B. Labadan, PhD
Illustrator and Layout Artist: Bismark E. Labadan

Management Team
Chairperson: Dr. Arturo B. Bayocot, CESO III
Regional Director
Co-Chairpersons: Dr. Victor G. De Gracia Jr. CESO V
Asst. Regional Director

Cherry Mae L. Limbaco, PhD, CESO V
Schools Division Superintendent

Rowena H. Paraon, PhD
Assistant Schools Division Superintendent

Members
Mala Epra B. Magnaong, Chief ES, CLMD
Neil A. Improgo, EPS-LRMS
Bienvenido U. Tagolimot, Jr., EPS-ADM
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Ray O. Maghuyop, EPS-Math
Joel D. Potane, LRMS Manager
Gemma P. Pajayon – PDO II
Lanie M. Signo – Librarian II

Printed in the Philippines by
Department of Education – Division of Cagayan de Oro City
Office Address: Fr. William F. Masterson Ave Upper Balulang Cagayan de Oro
Telefax: (08822)855-0048
E-mail Address: cagayandeoro.city@deped.gov.ph

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Quarter 2 - Module 9:
Earth's Interior and Its Mechanisms

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Module 9

What This Module is About

The Earth is so vast and contains so many mysteries. This is the reason why scientists for centuries are still exploring the planet and try to unlock the mystery behind its wonders.

In the previous module, you have learned about rocks and other factors with their importance to our planet and existence. Now, let us dig under and see the beauty behind the surface of our planet. Have you ever asked yourself what is inside the earth? Why is the Earth's interior hot? How is magma made? In this module you will learn about the internal structure and mechanisms of the Earth. This will also help you visualize and understand the Earth's composition and structure.

This module also consists of activities that will help develop your critical thinking skills to have a better and deeper understanding of the planet where you live in.

The following are the lessons contained in this module:

Lesson 1: Heat in Earth's Interior

Lesson 2: What Happens After Magma Formation?

Lesson 3: Rocks Under Different Types of Stress

What I Need to Know

At the end of this module, you should be able to:

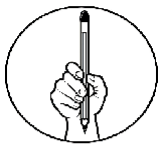
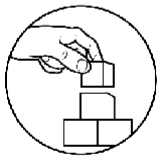
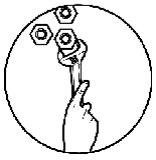
1. Explain why the Earth's interior is hot
2. Describe what happens after magma is formed
3. Describe how rocks behave under different types of stress such as compression, pulling apart and shearing

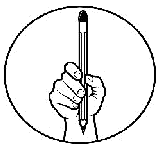
How to Learn from this Module

To achieve the objectives cited above, you have to do the following:

- Take your time reading the lessons carefully.
- Follow the directions and/or instructions in the activities and exercises diligently.
- Answer all the given tests and exercises.

Icons of this Module

	What I Need to Know	This part contains learning objectives that are set for you to learn as you go along the module.
	What I know	This is an assessment as to your level of knowledge to the subject matter at hand, meant specifically to gauge prior related knowledge
	What's In	This part connects previous lesson with that of the current one.
	What's New	An introduction of the new lesson through various activities, before it will be presented to you
	What is It	These are discussions of the activities as a way to deepen your discovery and understanding of the concept.
	What's More	These are follow-up activities that are intended for you to practice further in order to master the competencies.
	What I Have Learned	Activities designed to process what you have learned from the lesson
	What I can do	These are tasks that are designed to showcase your skills and knowledge gained, and applied into real-life concerns and situations.



What I Know

Pretest: MULTIPLE CHOICE:

Directions: Read and understand each item and choose the letter of the correct answer. Use separate sheet of paper for you answer.

1. The hot molten rocks found inside the Earth are called _____.
   A. Lava B. magma C. minerals D. plates

2. Which of the following processes, the movement of gas or liquid in which the warmer parts move up and the cooler parts move down?
   A. convection B. conduction C. induction D. radiation

3. Which of the following layers of the Earth is in liquid form?
   A. crust B. mantle C. outer core D. inner core

4. How is radioactive heat produce?
   A. From the Earth's formation
   B. From the redistribution of heat
   C. From the decays of isotopes
   D. From the movements of plates

5. Which of the following processes is involved in boiling water?
   A. conduction B. radiation C. convection D. induction

6. The rate of cooling of a magma or lava is reflected by the _____ of the rock.
   A. mineralogy
   B. texture
   C. color
   D. density

7. The temperature (at least a minimum estimate) from which the melt cooled is reflected by the _____ of the rock.
   A. mineralogy
   B. texture
   C. color
   D. density

8. Where would you expect to find the largest crystals in a lava flow?
   A. Near the top surface of the flow
   B. Near the center of the flow
   C. Near the bottom of the flow
   D. Crystals would have the same size throughout the flow

9. According to Bowen's reaction series, which of the following pairs of phases are likely to be incompatible?
   A. quartz and alkali feldspar
   B. ca-Plagioclase and olivine
   C. quartz and olivine
   D. na-plagioclase and amphibole

10. What would be the plate tectonic settings where you would expect to find granitic/rhyolitic rocks?
   A. subduction zone
   B. continent/continent collision
   C. spreading center
   D. transform boundary

Lesson 1

Heat in Earth's Interior

What I Need to Know

We all know that what is inside a volcano is a very hot molten rock called magma. What about the interior of the Earth? Do they have the same temperature with the volcano? In your previous lessons, you have learned that heat inside the Earth moves continents, builds mountains and causes earthquakes. But the question is where does all this heat inside Earth come from?

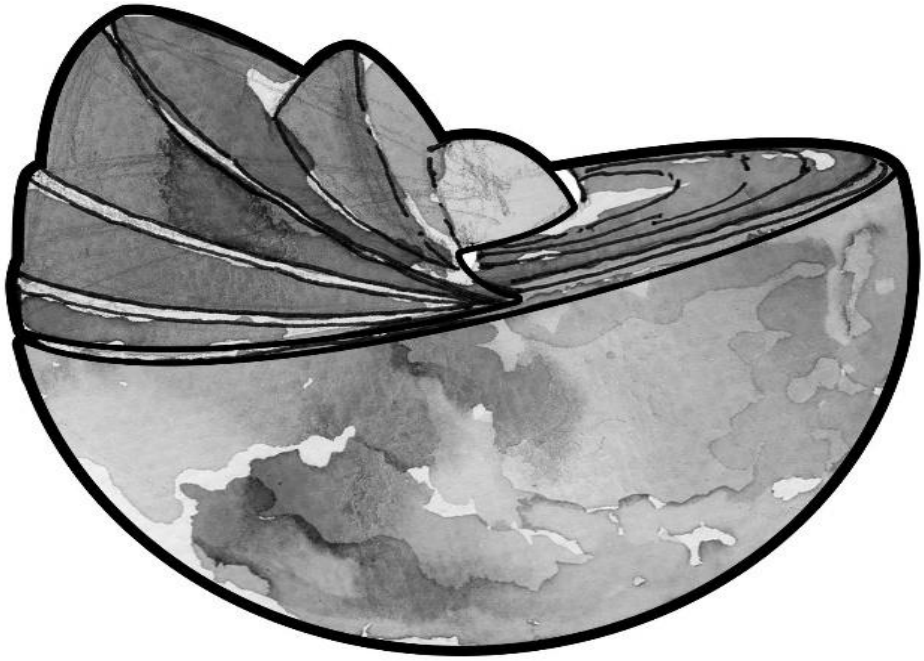


Figure 1: Layers of the Earth
Source: https://bit.ly/2B86bi8

In this module, you will explore and dig into the interiors of the Earth from the outer most layer which is the crust, then the mantle and finally the core: outer core and inner core). Out from these layers, you will try to discover how heat inside the planet is produced and its importance to the existence of all living beings.

At the end of this lesson, you are expected to identify why is there a need to have a constant heat inside the earth, how was it produced under.

What's New

Before we will discuss further, kindly answer this learning activity. This will also help you understand more about the process of weathering.

Activity # 1.1: Boiling
In this activity, you will understand the process of convection as one of the reasons of the heated Earth's interior.

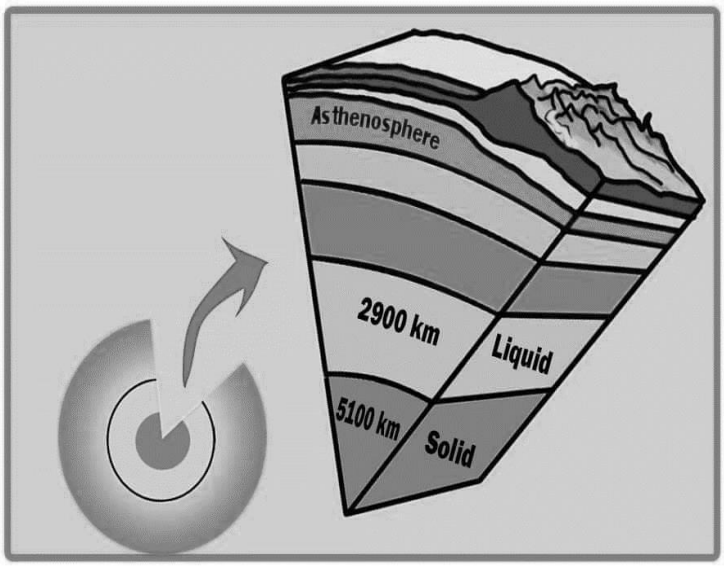
Materials:
Water, coffee or tea, beaker

Directions:
1. Put water into the beaker/(kettle) and boil.
2. Once it boils, pour the coffee or tea into the beaker/kettle. Observe what happens to the boiling coffee or tea.

Guide Questions:
1. What have you observed at the bottom of the water?
2. What is the direction of the heat?
3. What happens to the cooler water?
4. What happens to the coffee or tea? What can you observe from its color?
5. Why is there a mark of color in the beaker? What does it represent?

What Is It

The activity above shows the process of convection. Convection is one of the reasons of the heat in the earth's interior. The process tells us that the heat in the earth's interior is redistributed. The less dense material rises and more dense material sinks. Convection occurs at the upper mantle where hot rock rises and slightly cooler rock sinks.



Source: https://bit.ly/2YxxVG0

The heat driving mantle convection has three main sources. The first one is the "Primordial" heat or the left over accretion and differentiation that lead to the Earth's core formation. The second cause of interior heat is the decay of radioactive isotopes which are mainly potassium, thorium, and uranium. Lastly is the tidal friction from the Moon's pull on the Earth. This process of mantle convection is the main reason why this heat escapes from the interior of the Earth.

What's More

Activity #1.2: Convection and Magma formation

Materials:

Water, pan, chocolate powder, 3 candles

Procedure:

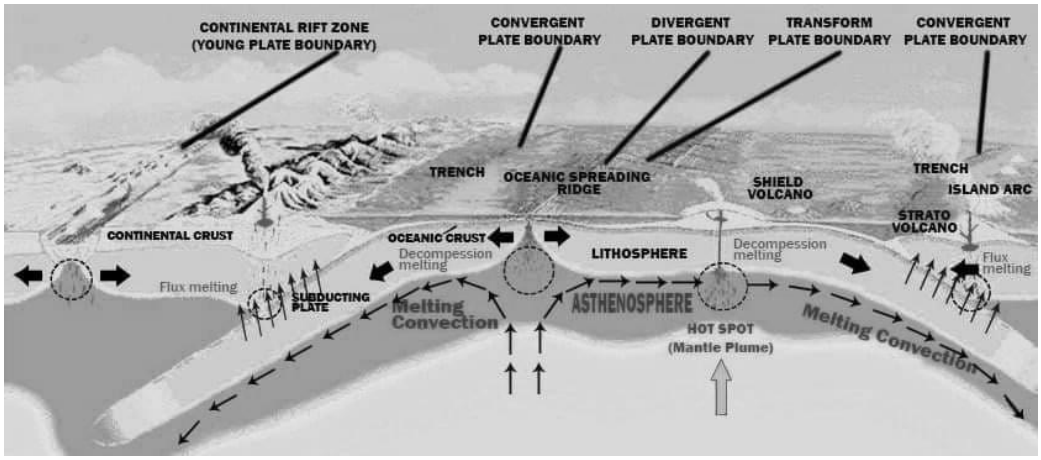
1. Put water in the pan.
2. Sprinkle the pan with the chocolate powder until it is thickly covered.
3. Light 1 candle and place it under the center of the pan.
4. When it starts to boil, light the 2 remaining candles and put them in the opposite sides of the pan.

Guide Questions:

1. How is heat transferred in the activity?
2. What happens to the powder when water starts to boil?
3. Is there any difference of the boiling product when the 2 candles are added?
4. How does the activity relate to the formation of magma?

What Is It

MAGMA FORMATION



Source: https://bit.ly/3g2sm8p

The earth is made of entirely solid materials-crust and mantle. Magma can only be formed in places where pre-existing solid rocks undergo melting. This melting is due to the following reasons:

- Decrease in pressure affecting hot mantle rock. Hot mantle rocks rise to the shallow depths in the Earth only in the mantle plumes.
- Addition of volatiles or compounds that have low boiling points. When these volatiles mix with hot, dry rock, they decrease the melting point of the rock which then helps in breaking the chemical bonds to allow melting
- Heat transfer from the rising magma. The rising magma from the mantle brings in heat and transfers this heat to the surrounding rocks at the shallower depths which may melt.

These are the following places where magma can be formed:

- **Mid-oceanic ridges**-rising magma in the mantle convection cell brings heat to the surface, transferring heat to the overlying rocks.
- **Mantle plumes**-the transfer of heat and decompression result to magma generation. It has a deeper source of heat.
- **Subduction zones-**oceanic crustal rocks are formed along the spreading centers typically beneath several kilometres of seawater. The presence of water during generation results to the formation of hydrous minerals. As the oceanic slab is down-thrusted along subduction zones, the change in temperature and pressure conditions brings about mineral instability.

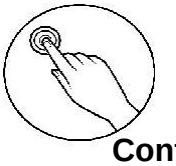
What I have learned

Activity #1.3: Schematic Diagram

Instruction: Draw an schematic cross section of the earth, showing the different layers of the earth. In your illustration label and Include the following:

1. Different tectonic settings where magma is generated.
2. Type of melting that is usually associated with the setting identified in no. 1.
3. Heat transfer mechanism and the direction of heat transfer.

Lesson 2 What Happens After Magma Formation



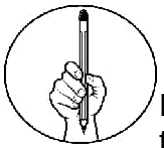
What I Need to Know

Content Standard: The learners demonstrate an understanding of the geologic processes that occur within the Earth. The learners will be able to make a simple map showing places where erosion and landslides may pose risks in the community.

Learning Competencies: The learners will be able to describe what happens after magma is formed **(S11/12ES-Ic-16**)

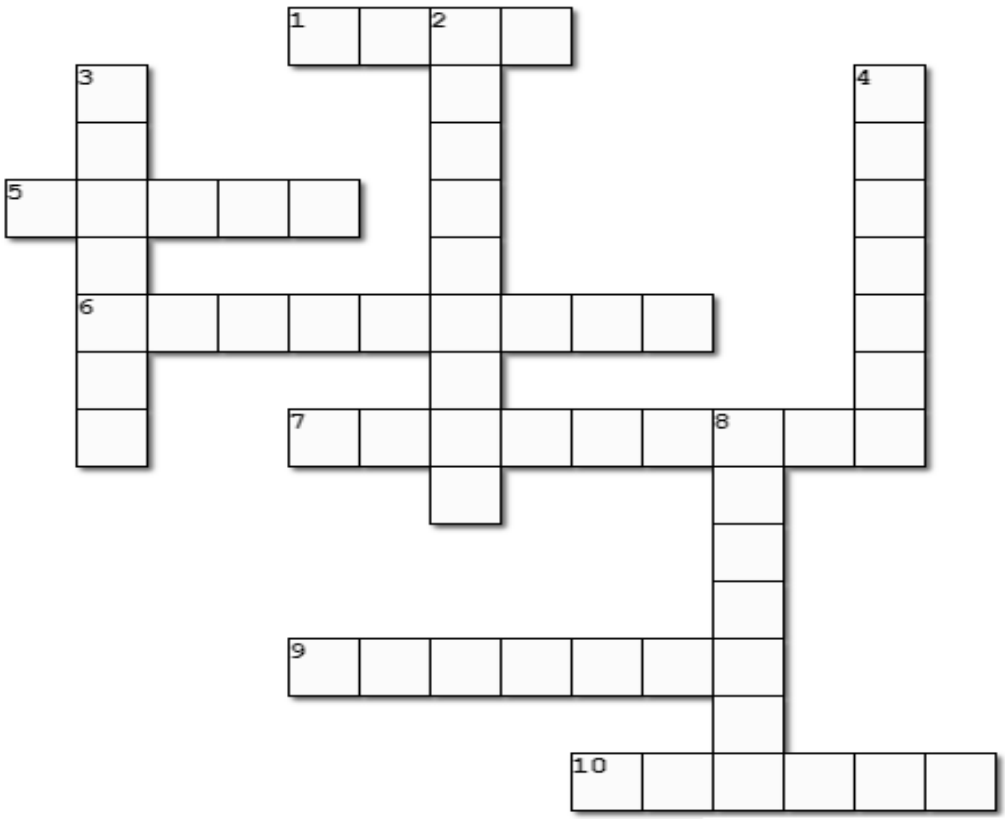
At the end of the lesson, the learners will be able to:

1. Explain how and why magma rises up,
2. Identify, understand, and explain magmatic differentiation mechanisms operating beneath the surface of the Earth



What I Know

Recall your prior knowledge about the formation of igneous rocks and try to answer the crossword puzzle below.



Across

1. magma that flows outside the volcano during eruption
5. molten rocks and other materials beneath Earth's surface
6. rocks formed and solidified inside the volcano
7. rocks formed outside the volcano
9. an opening on Earth's surface where molten rocks, gases and other materials flow
10. a very common extrusive rock which are very fine-grained

Down

2. resistance of a fluid to flow
3. a common intrusive igneous rock
4. mineral that are found in mafic and ultramafic igneous rocks
8. rocks formed from cooling and solidifying magma

What Is It

All **igneous rocks** originate beneath earth's surface in the molten state called **magma**. Magma is hot molten rock containing chemical elements from uppermost mantle called the **asthenosphere**. It also contains dissolved gases such as water, carbon dioxide, sulfur dioxide, and possibly few crystals.

Magma is formed in the mantle where the subducted oceanic plate is located. Temperatures and pressures in this area are extremely high to cause water to sweat into the mantle. The addition of water into the hot mantle rocks causes rock to melt and form magma. This magma begins to rise because it is less dense compared to its surroundings.

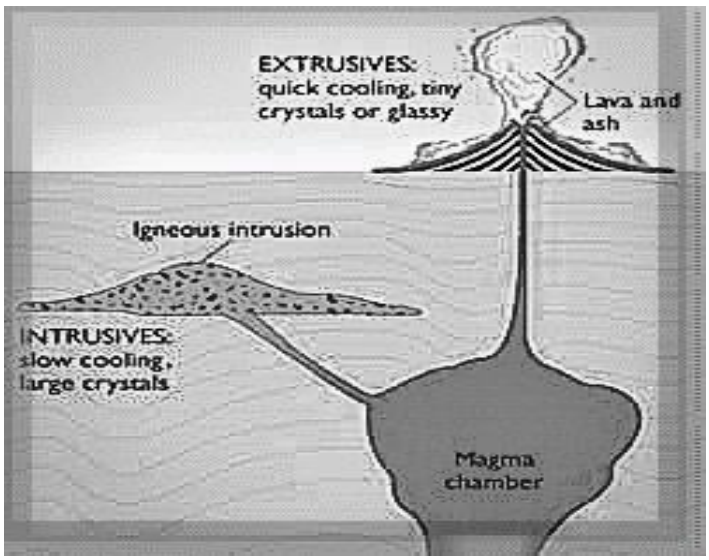


Fig. 1. Two processes as magma rises up: (1) erupted out to the surface through volcanoes (2) solidifies within the lower levels. (Source:http://en.wikipedia.org/wiki/Igneous_rock#/media/File:Igneous_rock_eng_text.jpg. Accessed: June 10, 2020)

At deeper levels in the surrounding mantle rock, magma rises and passes through mineral grain borders and cracks. **At lower levels**, magma may no longer rise because its density is almost the same as that of its surroundings. When the magma solidifies at an area, it forms different types of **plutonic bodies**.

At very high temperatures (over 1300°C), most magma is completely liquid because there is too much energy. **Silicon** and **oxygen** combine to form **silica tetrahedral**. As cooling continues, compounds of tetrahedral start to link together to make chains (**polymerize**). These silica chains make the magma more viscous. Crystals start to form as magma continues to cool.

To understand more about viscosity, do the activity below. Follow the procedures and answer the questions.

What's New

Learning Activity #2.1: Properties of Magma – Viscosity

I. Objective

a. Define what viscosity is? and explain the factors that affect viscosity.

II. Materials

- 3 flat containers (sauce pan or paper plate)
- Honey
- Oil
- Water

III. Procedure

1. Prepare the materials. Make sure to observe cleanliness in preparing to avoid mess in your area.
2. Slowly pour the water in container 1, oil in container 2, and honey in container 3. Observe carefully how the liquids flow.
3. Describe the flow of liquids and write your observation.

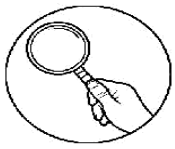
IV. Observation

Q1. Which among the liquid samples flow the fastest?

Q2. Which among the liquid samples flow the slowest?

Direction: Copy the table in a separate sheet of paper and write your description/observation.

Sample	Ability to flow (Very fast, fast, slow)	Observation
1. Water		
2. Oil		
3. Honey		



What Is It

Viscosity is an extent of a fluid's resistance to flow. Magmas with low viscosity flow faster than those with high viscosity. Temperature, silica content and volatile content affect the viscosity of magma. The table below shows the factors that affect the viscosity of magma.

Factor	Effect to Viscosity
↑ temperature	↓ viscosity
↑ Silica content (SiO2)	↑ viscosity
↑ dissolved water (H2O)	↓ viscosity

Table 1. Different factors that affect magma's viscosity

What's New

Norman L. Bowen explained why certain minerals occur together while others are almost never linked with one another. In the early 1900s, Bowen heated powdered rock material until it melted. He cooled down the molten material and observed the minerals that formed in the rocks. He repeated this process with gradually lower temperatures and the results led him to the now called **Bowen's reaction series**. Based on his works, one can conclude from the minerals present in a rock the conditions (temperature and pressure) under which the rock had formed.

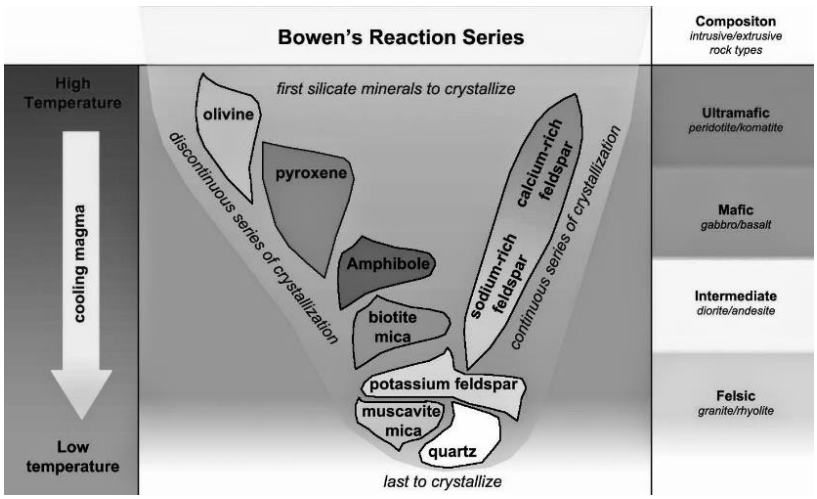
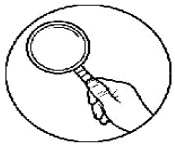


Fig. 2. Bowen's Reaction series

(Source:http://www.geologyin.com/2014/09/how-does-bowens-reaction-series-relate.html)

Certain minerals are unchanging at higher melting temperature and crystallize before those stable at lower temperatures. **Crystallization** in the continuous and discontinuous branches takes place simultaneously. **Continuous branch** contains only plagioclase feldspar. **Discontinuous** branch describes how **ferromagnesian minerals** in the magma are changed if temperature changes. The primary formed crystals, olivine, reacts with the remaining melt as the magma cools down, and recrystallizes into **pyroxene**. Continued cooling will transform pyroxene into

amphibole. If all of the iron and magnesium in the melt is consumed before all of the pyroxene recrystallizes to amphibole, the ferromagnesian minerals in the solidified mantle would be amphibole and pyroxene.



What Is It

Magmatic differentiation is the process of generating one or more subordinate magmas from single parent magma.

Crystal Fractionation is a chemical process by which the structure of a liquid, such as magma, changes due to crystallization.

There are different processes of crystal fractionation:

- **Crystal settling** happens when heavier minerals crystallize first and settle down while the less dense minerals crystallize at the final stages. Bowen's reaction series shows that heavier minerals such as olivine and Calcium-rich plagioclases are created first, leaving the magma more silicic.
- **Partial Melting** as described in Bowen's reaction series, quartz and muscovite are mostly formed under low temperature conditions, making them the first to melt from the parent rock once exposed in higher temperature and/or pressure. Partial melting of an **ultramafic rock** in the mantle forms basaltic magma.

What's New

Learning Activity #2.2: Partial Melting **(This activity is optional)**

I. Objectives

1. Understand the process of partial melting
2. Explain the process of partial melting

II. Materials

Materials are provided by the teacher for demonstration. Laptops may also be used in case of video presentation of the activity.

III. Procedure (teacher demonstration or video presentation)

1. Prepare the two beakers. In each beaker, put about 1 cm of fine gravel mixed completely with about 2 cm of candlewax that has been cut into pieces the same size as of gravel.
2. Show the students the beaker containing the mixture of gravel and chopped candlewax before heating.

Q1. What will happen if the beaker is heated until the wax melts?

3. Warm one of the beakers over a Bunsen until the candlewax melts. At this stage, the gravel sink to the bottom, leaving a layer of pure candlewax at the top. Leave the beaker to cool and the wax to solidify.

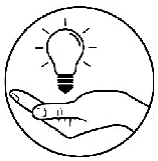
Q2. Explain what happens when the beaker was heated.

What's More

When solids made up of mixed materials start to melt, the materials with the lowest melting point melt first – giving a partial melt. Materials with the highest melting points often don't melt, but settle through the partially molten material to the bottom. The material that flows to the top cools and solidifies; it contains only of the lower melting point material.

Magma mixing happens when two different magma rises up, with the more buoyant mass overtakes the slower rising body. **Convective flow** then mixes the two magmas, producing a single, and intermediate (between the two parent magmas) magma.

Assimilation or contamination of magma by crustal rocks is a reaction that occurs when the crust is mixed up with the rising magma. When magma rises to the surface, the surrounding rocks may dissolve (due to the heat) and eventually get mixed with the magma. This scenario produces change in the chemical composition of the magma unless the material being added is the same as the magma.



What I have learned

Learning Activity #2.3

Answer the following questions in your interactive science notebooks.

1. Define viscosity.

2. Identify three major factors that control the viscosity of the magma.

3. Describe how viscosity affects the movement of magma.

4. How does magma composition change during crystallization?

5. What is Bowen's reaction series?

Lesson

3

Rocks Under Different Types of Stress

What I Know

I. MULTIPLE CHOICE:

Directions: Read and understand each item and choose the letter of the correct answer.

1. A crack in a rock layer where the rock on either side is moving is called___.
   A. fold C. fracture
   B. fault D. slit

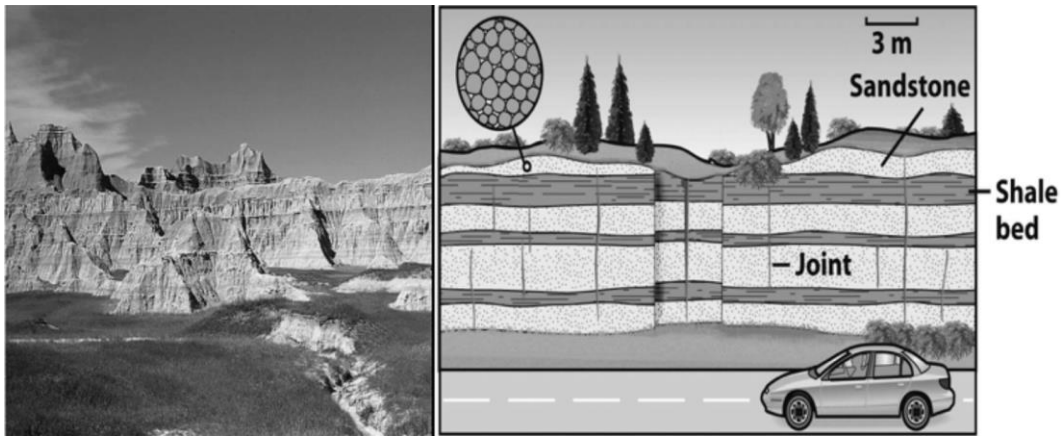
2. What do you call the deformation in rock layers where there is a change in shape without breaking?
   A. fold C. fracture
   B. fault D. slit

3. What do you call an upward fold in rocks?
   A. Monocline C. Syncline
   B. Anticline D. Incline

4. A downward U-shaped fold in a rock layer is called _____.
   A. Monocline C. Syncline
   B. Anticline D. Incline

II. "Deformed vs Undeformed"

Direction: Observe the illustrations shown and answer the questions that follow.



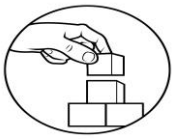
Source: Earth: Portrait of A Planet, 3rd Edition, by Stephen Marshak. Chapter 11: Crags, Cracks and Crumples: Crustal Deformation and Mountain Building

Q1. What have you observed in the illustration?

Q2. What do you think happened?

What Is It

Rock deformation includes any change in shape, position, and/or volume of a rock in response to stress. When layers of rocks are tilted, folded, or misplaced, this indicates that deformation has occurred. **Stress** is the force per unit area applied on the rock layers. **Strain** is the change in shape or volume of the rock that undergone stress. Thus, stress causes the strain on rock layers.



What's More

Activity 3.1: Types of Stress

I. Objective:

1. Demonstrate and observe how rock layers or materials undergo stress

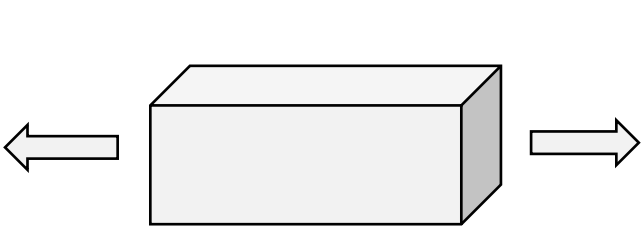
II. Materials

b) Block of clay
c) Interactive Science Notebook

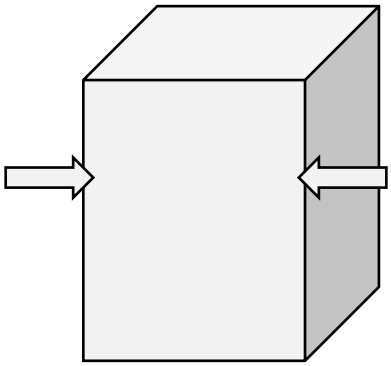
III. Procedure

1. Take a block of clay. It should be 5 cm long, 5cm wide and 2 cm thick.
2. Demonstrate compression by slowly pushing on opposite sides. Sketch what you have observed.
3. Reshape the clay and demonstrate tension by pulling slowly both ends of the clay in opposite directions. Again, sketch your observation.

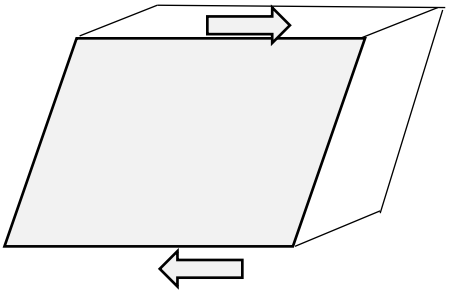
4. Lastly, reshape the clay and demonstrate shear stress by placing your hands flat on opposite sides of the clay block and gently move your hands in opposite directions. Sketch you observations. Below is an illustration for reference.



Tensional Stress



Compressional Stress



Shear Stress

IV. Observation: (Write your observation in a separate sheet of paper)

Q1. Describe the shapes of the clay after applying stress. What are your own definitions of the following?

a. Elastic
b. Ductile
c. Brittle

Q2. Given examples wire, clay, metal spring, and rubber band, classify if these materials are elastic or inelastic. If inelastic, classify again if it is ductile or brittle.

5. Write your observations in the table below.

Material	**Property**
Wire	
Clay	
Metal	
Spring	
Rubber band	

The **magnitude of stress** is not just a function of the amount of stress but also relates to the area over which the force is applied. There are different stages of deformation as shown:

- **Elastic deformation** occurs when the strain is reversible. This means that material that returns to its original shape once the stress that deforms it is removed.
- **Ductile deformation** occurs when the strain is irreversible. Rocks layers or the materials respond to stress by bending or deforming without breaking.
- **Fracture deformation** is an irreversible strain wherein the materials breaks because these are mostly **brittle**.

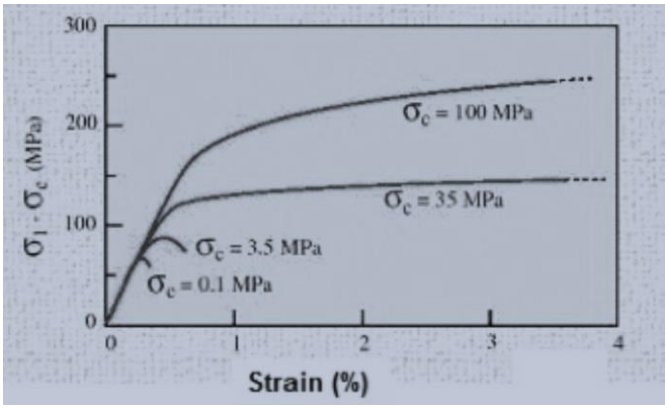
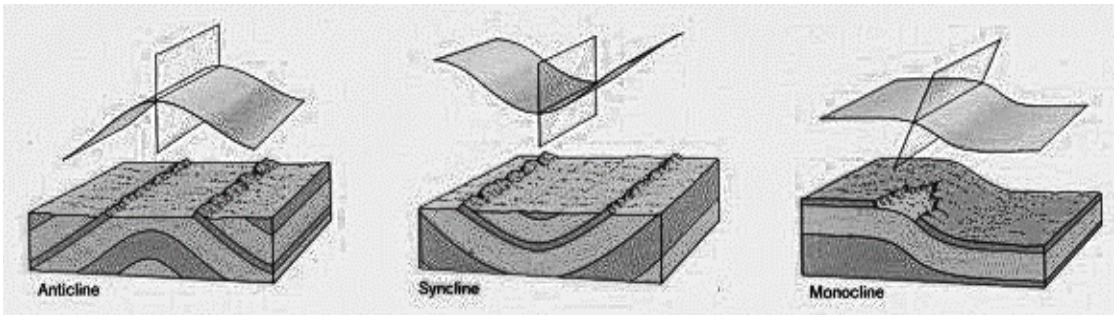


Figure 2. The graph shows the relationship between confining pressure and strain. (Source: http://structuralgeology.50webs.com/pconf.htm)

Low temperature, low confining pressure, and high rate of strain increase the brittle properties of rock. High temperature, high confining pressure and low rate of strain increase the ductile properties of rocks. The material's composition determines the point at which brittle-ductile transition occurs.

Folds are formed when rock layers or materials are deforming plastically under compressive stress. Most of these materials do not return to their original shape. If stress is increased, the rocks may undergo more folds and even fracture. There are three types of folds:

- **Monocline** occurs when there is a simple bending of rock layers so that they are no longer horizontal.
- **Anticline** occurs when a fold bends upward.
- **Syncline** occurs when a fold bends downward.



(Source:https://www.geocaching.com/geocache/GC7V7DB_you-gotta-know-when-to-fold-em?)

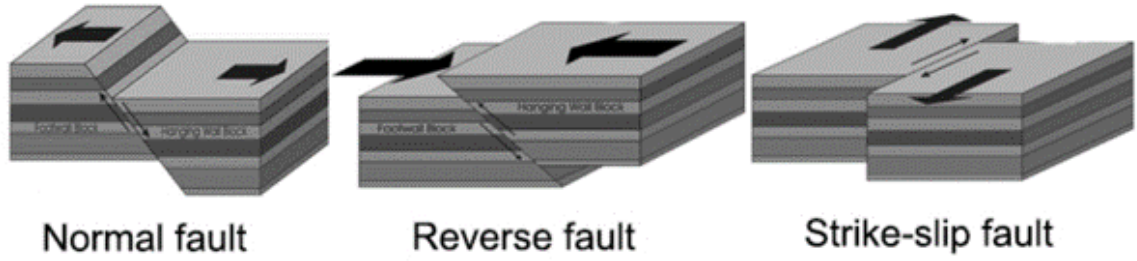
Fig. 3.Types of folds under compressive stress.

Faults occur when too much stress is applied to rock layers. Rocks will undergo fracture or rock materials will break. If there is a sudden motion along faults, it causes the rocks to break and move suddenly. The energy released during the movement of fault called **earthquake.**

Slip is the distance that rocks move sideways a fault. It can be up or down the fault plane. Slip is relative. This is because there is usually no way to know whether both sides moved or only one. That angle that faults lie to the horizontal of the surface of the Earth is called the fault's **dip.** If the fault's dip is inclined relative to the horizontal surface, the fault is a **dip-slip fault**. There are two types of dip-slip faults.

- **Normal faults** is described when the hanging wall drops down relative to the footwall.
- **Reverse faults** is when the footwall drops down relative to the hanging wall.

Strike slip faults are vertical fractures where the blocks have mostly moved horizontally. **Oblique-slip fault** is a fault which has components of dip slip and strike slip.



(Source:) https://www.chegg.com/homework-help/questions-and-answers/

Fig. 4. Types of fault and their movement.

ASSESSMENT

Post-test: MULTIPLE CHOICE:

Directions: Read and understand each item and choose the letter of the correct answer. Use separate answer sheet of paper.

1. Which of the following processes is involved in boiling water?
   A. convection B. radiation C. conduction D. induction

2. The hot molten rocks found inside the Earth is _____.
   A. lava B. Plates C. minerals D. magma

3. Where would you expect to find the largest crystals in a lava flow?
   A. near the center of the flow
   B. near the bottom of the flow
   C. near the top surface of the flow
   D. crystals would have the same size throughout the flow

4. Which of the following layers of the Earth is in liquid form?

A. crust B. outer core C. mantle D. inner core

5. How is radioactive heat produce?

A. From the decays of isotopes
B .From the Earth's formation
C. . From the redistribution of heat
D. From the movements of plates

6. Which of the following processes, the movement of gas or liquid in which the warmer parts move up and the cooler parts move down?

A. convection B. radiation C. induction D. conduction

7. Describe the plate tectonic settings where you would expect to find granitic/rhyolitic rocks

A. transform boundary
B. zone. subduction
C. spreading center
D. continent/continent collision

8. The temperature (at least a minimum estimate) from which the melt cooled is reflected by the _____ of the rock.

A. color
B. texture
C. mineralogy
D. density

9. According to Bowen's reaction series, which of the following pairs of phases are likely to be incompatible?

A. . quartz and olivine
B. ca-Plagioclase and olivine
C. quartz and alkali feldspar
D. na-plagioclase and amphibole

10. The rate of cooling of a magma or lava is reflected by the _____ of the rock.

A. color
B mineralogy
C texture
D. density

KEY TO ANSWERS

Pre test

1. B	**6. B**
2. B	**7. A**
3. C	**8. B**
4. C	**9. C**
5. C	**10. A**

Lesson 1:

Activity 1: Boiling

1. There is heat at the bottom of the water.
2. The heat is rising to the top from the bottom
3. The surface water becomes hot, and it radiates its heat into the air and then cools.
4. The cooler water sinks into the space vacated by the ascending warmer water. The cooler water starts to warm again while the one that rises starts to cool.
5. The process goes on forming a top to bottom circulation of water

Activity 2:

1. Convection is shown by the presence of mounds and cracks in between the mounds, radiation is illustrated by the emitted gas directly above the heat source and conduction is evidenced by the submerging chocolate powder along the rims of the pan.
2. The chocolate powder starts to rise forming a conical shape then cracks and emits gas. Slowly, the chocolate powder around it starts to subside and get wet. The heat source is directly beneath this zone so the hotter water is rising in that area. But since the chocolate powder traps the water, the hot water starts to move laterally under the chocolate powder forming the conical shape before it manages to create a crater where the water is released as gas
3. When the two candles were added a crack starts to from and the chocolate powder sinks slowly in these regions.
4. The water represents the asthenosphere; the chocolate powder represents the lithosphere; and the candles represent the heat source. Magmas are formed directly above the heat sources due to relatively high temperature.

1. Define viscosity.

Answer: Viscosity is the measure of a substance's resistance to flow.

2. Identify three major factors that control the viscosity of the magma.

Answer: The three major factors controlling the viscosity of magma and/or lava are temperature, silica content and volatile content.

3. Describe how viscosity affects the movement of magma.

Answer: Viscosity is the measure of fluid's resistance to flow. Mafic or basaltic magma, when compared to a felsic or granitic magmais more mobile and flows faster as it is less viscous due to its higher temperature and less silica content.

4. How does magma composition change during crystallization?

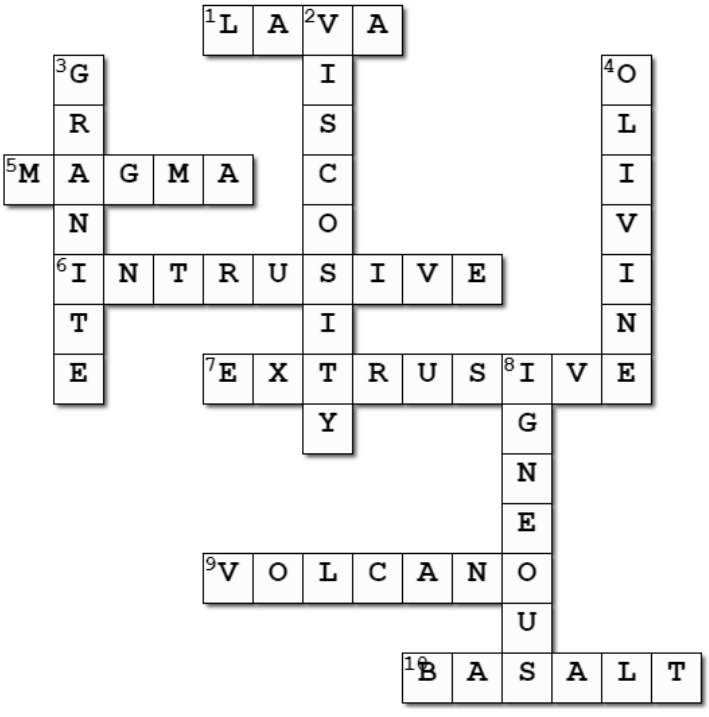
Answer: Magma becomes progressively more silica-enriched as crystallization progresses.

5. What is Bowen's reaction series?

Answer: Bowen's reaction series describes the sequence of mineral crystallization in a cooling magma. The two branches of theseries are the continuous and discontinuous branches. As the temperature drops, the discontinuous branch describes how minerals are transformed into another type of mineral while the continuous branch shows how calcium-rich plagioclase feldspar is progressively changed into sodic plagioclase. The reverse of Bowen's reaction series describes the melting of rock.

Sample	Ability to flow (Very fast, fast, slow)	Observation
1. Water	Very fast	Own observation
2. Oil	Fast	Own observation
3. Honey	slow	Own observation

Activity 3.1



Lesson 2:

Material	Property
rubber band	elastic
metal wire	inelastic, ductile
clay	inelastic, ductile (some will say inelastic, brittle if stress is applied suddenly)
metal spring	elastic (some may say ductile if the spring is stretched too far

KEY TO ANSWERS

Post- test

1. A	**6. D**
2. D	**7. B**
3. A	**8. A**
4. B	**9. A**
5. A	**10. C**

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For inquiries and feedback, please write or call:

Department of Education – Bureau of Learning Resources (DepEd-BLR)

DepEd Division of Cagayan de Oro City
Fr. William F. Masterson Ave Upper Balulang Cagayan de Oro
Telefax: ((08822)855-0048
E-mail Address: cagayandeoro.city@deped.gov.ph